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WDFW HABITAT GUIDELINES

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3 WATERSHED, REACH, AND SITE ASSESSMENT (ESTIMATED PAGES ????)

There are three fundamental levels of assessment: watershed assessments, reach assessment, and site assessment.

Watershed, reach, and site assessments are conducted to identify physical characteristics of a watershed, reach and/or site that relate to biological conditions and functional processes they depend on. A watershed assessment characterizes the entire basin and includes inputs to the channel, distribution of habitats and functions within the watershed, and characterizes the relationships between these watershed characteristics and the quality of its habitat. A reach assessment covers a specific length of river corridor and focuses on channel character, channel processes, and restoration opportunities. A site assessment describes conditions at a specific location proposed for an action. Reach assessment and site assessment are generally conducted simultaneously.

3.1 Objectives of Assessment

The key distinctions among the three levels are:

- Watershed assessment defines broad scale setting and inputs to the reach
- Reach assessment focuses on channel and floodplain characteristics within project area
- Site assessment provides information specific to design and baseline monitoring data

Roni et al[1] describe three steps to identify degraded habitat processes that need to be restored. The first two are to identify the types and natural rates of habitat-forming processes and determine where those processes are altered and the factors responsible for that alteration.

3.1.1 Watershed Assessment:

Watershed assessments are included in restoration design for the following reasons:

- Assessment is the first step in identifying appropriate restoration actions and optimizing restoration activities.
- Proposed restoration projects must be considered in their landscape and watershed contexts on a scale appropriate to the needs of affected plant and animal species. In order to restore the structure and function of whole ecosystems, need to strive to

understand and respond holistically to cumulative ecological impacts. Restoration or management of one part of a watershed will affect other parts of the aquatic ecosystem. Restoration plans must be developed with a landscape perspective—an understanding of how specific sites are related to the remaining resources in the watershed or region.

- Even if focus is limited to salmonid restoration, the life history of salmonids depends on virtually all portions of a watershed. Therefore, to fully address restoration of salmonid (and related aquatic species) habitat, must act on a watershed scale and restore or ensure proper function throughout.
- Observed impacts and habitat degradation are often the result of cumulative impacts, which can only be fully understood within a watershed context
- Watershed assessment facilitates integrated watershed planning which is preferred over piecemeal actions (reference Chapter 1).
- Watershed assessment allows for consideration of problems and solutions with respect to influences that cannot be controlled at the site, for example, sedimentation of spawning gravels as a result of sedimentation from land use practices upstream, or loss of LWD in rivers due to forest practices upstream.
- Some level of reconnaissance work is necessary to establish the watershed level conditions that must be taken into account for restoration design.
- Multiple site-specific projects within a single watershed may warrant a watershed analysis.

Define watershed: "A watershed is the area of land that water flows across or under on its way to a river, lake, or ocean. It includes all surface fresh water and adjacent estuaries and marine areas"[2]

3.1.1.1 Objectives of Watershed Assessment

Objectives of assessment may differ substantially if done as part of project-specific reconnaissance, as opposed to watershed management plan. Different project objectives will dictate different assessments.

- Intent of watershed assessment is to evaluate habitat condition, the causes of current condition, and the links between aquatic species and that habitat condition[3]
- General goal is to combine habitat inventory information with environmental impact assessment over a large area and to identify habitat restoration opportunities on larger geographic scales than site-specific habitat projects.
- Understand the scale of restoration required to satisfy the restoration objective.
- Identification of restoration and management opportunities.
- Identification of land use or other watershed constraints to resource/ecosystem restoration and recovery.
- Understand what present conditions are relative to continuum of change through time by

observing watershed trends.

- Distinguish between natural change and human activiey-degraded conditions.
- Consider both history and future changes that may affect viability and outcome of intended project.
- Identify input conditions such as hydrology, sediment and debris sources and sinks
- Serve as resource for subsequent investigators and management, therefore should be made publicly available, though at present there is no identified central repository for watershed studies
- To enable the consideration of major ecological interactions in a watershed so as to seek to nurture the watershed's restoration to a functioning system, rather than to manage for a single species or for a resource commodity such as game fish. [4](National Research Council 1992)
- Reid (1998)[5] lists typical Questions that Watershed assessment can address Naiman 1998 Page 477 :

a. "What areas are important for fish, and why?
b. Where has habitat been impaired?
c. What aspects of the habitat have changed?
d. What caused those changes?
e. What is the relative importance of the various habitat changes to fish?
f. What is the present trend of changes in the system?
g. Which changes are reversible?
h. What is the expected effectiveness of the potential remedies?
i. What are the effects of those remedies on thither land uses and ecosystem components?
j. What are the relative costs of the potential remedies over the long term?"

Paragraph on relative cost of watershed assessment and habitat restoration

- Many projects have a high risk of failure if the watershed processes and conditions are not well understood. High cost and high-risk projects should not be undertaken without a watershed assessment.
- Assessment costs are part of the cost of doing business, they should be included in project budget just as project design and monitoring should
- More cost effective in long run to do thorough assessments that can benefit future projects and watershed management

Watershed assessments already exist in some areas. Beware influence of differing objectives on nature of assessment. Advocate a comprehensive assessment. Watershed analysis is not necessarily conducted for a single project, but promotes the long-term viability of an overall restoration strategy.

Many habitat limitations are caused by watershed-scale impacts, or activities within the watershed that directly or indirectly impact downstream reaches and sites. Limiting factors may be better addressed by watershed management approaches, rather than local projects, or a combination may be appropriate.

Prioritization of restoration activities should consider watershed assessment. No point in physical modification for benefit of habitat if processes that maintain it are not supported by the watershed condition or character.

Refer readers to guiding principles for Ecosystem Function (what is the official citation for this?)

3.1.1.2 Components of Watershed Assessment

A watershed assessment should include reconnaissance, measurement, and documentation of existing conditions, historic conditions, and predicted future watershed conditions as they relate to the processes which influence and determine aquatic habitat. Roni et. al[6] provide a list of watershed processes and paired assessment methods used to determine the relationship between process and morphology, habitat, and water quality. The watershed processes are categorized as:

1. Sediment supply and erosion
2. Hydrology
3. Riparian and organic inputs
4. Nutrients
5. Energy inputs (light and heat)

Watershed assessment techniques are further detailed for each of these processes in WDNR (1995)[7], Skagit Watershed Council (1999)[8], and Watershed Professionals Network (1999)[9].

3.1.2 Reach Assessment:

Reach investigations are important to:

- Understand channel conditions and the relationship of channel processes to habitat value
- Provide a baseline for restoration monitoring
-

Define Reach: The designation of a reach varies depending on the type of project being considered.

- A length of stream with similar physical and habitat attributes and geomorphic processes
- See Montgomery and Buffington in Naiman River Ecology Management p. 24
- A length of stream between two grade controls
- “Design reach” – that area that might be influenced by the project
- Area that might influence the project, for example if a project is to deal with sediment, the reach analysis may include a sediment source, transport zone, and deposition zone.

Discussion on how to delineate reaches

- Identify grade control locations (bedrock, culverts, etc.)
- Slope breaks in profile
- Change in character of repeating channel features and sequences

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3.1.2.1 Objectives of Reach Assessment

Intent of reach assessment is to determine if reach is in equilibrium with watershed, and if reach provides process and function for habitat. Objectives of assessment may differ substantially if done as part of project-specific reconnaissance plan. Different objectives will dictate different assessments.

- Similar to watershed assessment, the intent of reach assessment is to evaluate habitat condition, the causes of current condition, and the links between aquatic species and that habitat condition[10]
- Identification of influences, trends, constraints and other factors that my affect a site-specific project. For example sediment input, channel migration zone, channel equilibrium
- Identify restoration and management opportunities.
- Identification of land ownership, infrastructure, and other constraints to restoration.
- Monitoring baseline data

3.1.2.2 Components of Reach Assessment

A reach assessment covers a specific length of river corridor and focuses on channel character and processes and restoration opportunities. Intent of reach assessment is to determine if reach is in equilibrium with watershed, and if reach provides process and function for habitat. Reach scale assessment can address the more specific components of restoration, where active physical modification is appropriate or needed. Identify and evaluate reach-scale causes of altered or impaired condition, such as livestock access and grazing practices, channel modifications and confinements,

Components of reach and site assessment overlap with those of watershed assessments. Reach scale analysis is essentially a more detailed evaluation of same components. Geomorph appendix covers much of this; need to make sure this corresponds with geomorph appendix.

- Physical assessment – channel form and character, identify confining features and channel modifications, channel and valley confinement. Channel form thresholds. Natural vs current conditions.
- Sediment assessment – identify sources of sed, evaluate equilibrium transport condition
- LWD assessment – quantify and qualify
- Habitat assessment – quantify and qualify
- Hydrologic assessment – floodplain connectivity, hyporheic interaction
- Riparian – quality and interaction with channel habitat
- Physical and biological monitoring baseline data

3.1.3 Site Assessment:

A site in the context of watershed assessment is the specific location of a proposed restoration or enhancement activity. Design details are catered to specific site conditions, and framed within the context of reach processes.

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Site investigations are important to…

- Understand potential, opportunities and limitations of the site
- Provide base information for specific restoration design
- Provide a baseline for restoration monitoring

Site assessment alone probably is never adequate; a minimum of reach level investigation is always warranted.

3.1.3.1 Objectives of Site Assessment

- Identify site limitations and opportunities
- Provide design data
- Provide monitoring baseline data

3.2 Determining Appropriate Level of Assessment

As described previously, assessment may be conducted at watershed, reach, or site scales. Ideally, assessment will be conducted at all levels for all projects. However, this may be impractical, and in some cases, unnecessary. The level at which assessment is conducted, the level of detail to which it is taken, and the minimum amount of assessment needed should be determined with the following considerations:

- Project objectives and overall habitat objectives (AHG)
- Spatial and temporal scale of problem
- Spatial and temporal scale of possible remedies

A discussion of cause and effect in fluvial habitat systems and response to disturbances that may determine the scale of problems and remedies are provided in Chapter 2 and in the Geomorphology Appendix.

Impacts to environmental resources are influenced by multiple factors, a fact which complicates the determination of historic impacts and the evaluation of potential future impacts. Reid (1998)[11], in light of the constraints listed previously, suggests that an understanding of watershed disturbance requires the following approach:

1. General patterns exhibited through a watershed are more important to consider than precise data. The watershed expression of the relationship among various data groups that is of greater importance than the specific components themselves.
2. Understanding of interactions among watershed components is more important than understanding of the individual components. For example, while timber harvesting may commonly result in increased sediment supply, the slope and aspect and nature of the soils

within the area harvested will determine to a large extent the volume and character of sediment released to the channel.

3. Qualitative descriptions and order-of-magnitude estimates are often of greater value than stimulus and response models, even stochastically based models.

3.2.1 Conditions That May Warrant High Level (Watershed) Assessment

Certain channel conditions may be indicative of watershed or channel instability and relatively large-scale issues. Channel conditions commonly resulting from system disturbance or watershed scale issues, that may therefore warrant higher levels of assessment, include aggrading channels, degrading channels, urban channels, and channelized stream reaches. This isn't to imply that aggrading and degrading channels are necessarily due to human causes; they are often natural conditions. These conditions require higher levels of assessment, as there are many potential causes, both natural and anthropogenic, and the appropriate treatment may vary with the cause. Furthermore, the likelihood of success in a project is minimal if underlying causes are not addressed.

3.2.1.1 Aggrading and Degrading Channels

Aggradation and degradation happen in response to a myriad of human or natural conditions – these are discussed in chapter 2 and the geomorphology appendix. Generally, both aggrading and degrading channels reflect an imbalance between sediment supply and sediment transport. Habitat restoration activities within aggrading and degrading channels warrant greater scrutiny and investigation in the assessment phase for the following reasons:

1. They are often indicative of an imbalance between sediment transport capacity and sediment supply, which is often indicative of systemic watershed land use problems.
2. They are often the result of actions taken outside of the problem site or reach, and therefore warrant assessment on a watershed scale.
3. The solutions often require changes in watershed or riparian management that affect areas outside the area of habitat deficiency.
4. When naturally occurring, aggradation within a channel may be a pulse moving through the system. This will only be identified through assessment that covers both temporal and spatial scales that extend beyond the project reach and recent time period.
5. Solutions may require changes or adjustment of base level. The effects of this change or adjustment may affect channel dynamics and landowners outside of the project reach.

3.2.1.2 Urban Channels

Urbanization affects stream channels both directly, through manipulation of the channel, hardening of banks, and installation of crossings, and indirectly by altering hydrologic and sediment regimes. These impacts and the common channel responses to these are covered in Chapter 2.

The challenge in evaluating urban impacts is to determine where in the process of response the channel is with respect to development, whether further development will occur within the watershed, and if so, what impacts it will have. Restoration work should accommodate the current and/or future input conditions. Watershed assessment becomes particularly difficult when a watershed is steadily developing, and the channel is responding, because the channel must continually adapt its response mechanism to changing watershed conditions.

1. Determine when full build-out was complete, or how much additional development will occur, how long to full build-out, and what impact will that have on hydrology and sediment supply
2. If fully developed, determine how long since full build-out was complete, evaluate with respect to new hydrologic and sediment regime

Booth, et al. [12] describe 5 common features of water resources altered by the cumulative effects of human activity in urbanizing watersheds:

1. Flow regime. Alteration of the flow regime results in channel erosion, altered channel morphology, washout of biota, unseasonable drying of streambed, disconnection from and loss of floodplains.
2. Physical habitat structure. Habitat is impacted by sedimentation and losses of spawning gravel, impediments to migratory movements, lack of woody debris, destruction of riparian vegetation and overhanging banks, lack of deep pools.
3. Water quality degradation includes increased water temperature, turbidity, oxygen sags, nutrient enrichment, and chemical contaminants.
4. Nutrients sources are altered, the supply and type of organic material inputs are reduced or altered, and reduced availability of fish carcasses.
5. Biotic interaction impacts include increased predation on young-of-year fish, genetic swamping form hatchery fish, alien plants, fish invertebrates, diseases and parasites, altered riparian vegetation.

3.2.1.3 Channelized Streams

Channelized streams are waterways that have been manipulated into relatively straight, single-thread channels for the purpose of diversion, flood control, agricultural use, or any other human interest. Many channelized streams were once natural stream channels, while others may originally have been created as drainage ditches (to drain wetlands) or diversion channels. Channelized streams are easily recognizable as very straight channels where no natural geologic controls would otherwise result in straight channel.

Differentiate between natural and unnatural origin as to whether it is appropriate to restore them or not. Consider special case of unnatural channel with habitat value. Consider risks restoring natural channel characteristics especially if the current channel has evolved to fit its current situation.

3.2.1.4 Confined/Constricted Channels

Stream, estuary, and tidal systems adjust to imposed constraints such as levees. Adjustments may be complete or on going, but they must be addressed before levee modification is undertaken. The crosssectional geometry or longitudinal profile of a stream channel may be significantly altered due to a levee on one or both banks. A geomorphic analysis is required to determine potential stream adjustments after the levee is removed. It may be necessary to employ other restoration techniques, such as restoration of floodplain, alignment and cross section, to avoid negative feedback from levee removal.

3.3 Conducting Watershed and Reach Assessments

3.3.1 Spatial and Temporal Scale Considerations

1. Spatial Context - Habitat varies spatially, particularly fish habitat, as a result of spatial variation in watershed character and process. Viewing habitat restoration in context of spatial variation is necessary for understanding how site-specific projects fit into grander context and may influence selection of appropriate measures.
   - Relation of source of material (sediment, wood, nutrients) to location of value or impact
   - Spatial relation of habitat value to place in watershed, stream order, etc.
   - Spatial relation of vegetation communities to habitat
   - Spatial relation of limiting factors and source of problems leading to limiting factors, for example, removal of shade trees in tributary streams may limit use through temperature extremes in lower elevation low flow habitat.
2. Temporal Context – Processes vary through time, seasonally, annually and on longer time scales. An understanding of where a reach and watershed is in time, relative to recent disturbance events, recent seasonal extremes, and longer-term gradual change is essential to effective planning. In particular, understanding the place in time relative to land use changes and human disturbance will help to determine the timeframe of impacts on resources.
   - Define current conditions compared to natural and/or historical conditions
   - Weather patterns through time – drought and wet cycles, as well as extreme events
   - Seasonal patterns of hydrologic regime – including timing of extreme events
   - Human land use disturbance – relative timing of land use change and response to it
   - Human channel manipulations - relative timing of channel manipulations and response
   - Lag time between action and response can be years or decades, and the greater the lag time, the more opportunity for additional influences to come in to play. For example, it may take decades for sediment inputs associated with logging to accumulate in downstream sites[13]
   - The importance of a single site to regional biodiversity is variable—ranging from highly critical during years of restricted habitat to redundant during years of expanded habitat. A site may contain few individuals for long periods of time but may provide an essential refuge for the population during periods of stress.[14]

3.3.2 Information Sources for Assessment

There may be considerable data available for many components of the assessment. Other components may require considerable original field data collection and data from remote sources.

3.3.2.1 Existing data and non-field data

- Air photos
- GIS
- Satellite photos
- Historic records
- USGS gage data
- Previous and related watershed assessments
- Literature search

3.3.2.2 Field Data

- Geomorphic data –see appendix
- Hydrologic data – see appendix
- Vegetation survey – field and remote approaches
- Biological assessment – refer to other documents (WA Agency staff – please assist in identifying most current and comprehensive guidance on conducting BA)
- Inventories
  - Sediment sources such as roads and landslides
  - Debris sources
  - Channel confinements such as revetments, levees and road crossings
  - Channel realignments
  - Disconnected estuaries, floodplains and floodplain habitats
  - Fish passage barriers

3.3.3 Constraints in Conducting Assessment

Assessments can be limited by the following:

- Property ownership and access may limit geographic scope of study
- Time – many studies take years to accomplish effectively
- Limited data – data limited by time, money, and scale, and history of data collection
- Scientific understanding of watershed processes is limited and comprehensive and reliable techniques for evaluating watersheds are lacking[15]. Additionally, no single discipline covers the many influencing variables, and thus, a study must be interdisciplinary and involve teams of varying disciplines
- Every watershed is a unique expression of its combined local geology, climate, vegetation, and land use pattern, therefore the sensitivity to impacts will vary and extrapolating between watersheds is risky.
- Rare events that occurred in the past and elsewhere in the watershed may influence sites a considerable distance downstream, many years or even decades later. Consequently, the temporal and spatial scope of analysis must take into consideration greater spatial and temporal scales of analysis than is typically conducted.

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3.3.4 Assessment Resources

There is currently no single resource for the State of Washington that provides comprehensive guidance and instruction in how to conduct an assessment for stream habitat restoration.

In May, 2001 the Joint Natural Resources Cabinet published *Guidance on Watershed Assessment for Salmon*. The guidance provided in this document is oriented towards identifying problems and issues in salmon recovery for specific watersheds. This document contains an appendix that lists the various types of assessment that may be included and their relation to existing statewide information sources. It promotes three stages of watershed assessment:

1. Identify limiting factors to salmon recovery using available information and develop general management goals and address obvious remedies for existing problems.
2. Determine what processes and land use practices are leading to the limiting factors through analysis and modeling, and select restoration strategies and projects for salmon recovery.
3. Establish details of relationship between salmon and habitat conditions by conducting extensive data collection, analysis, modeling and monitoring to facilitate prioritization of restoration activities and establish a basis for adaptive management and monitoring.

WA Agency staff and reviewers – please provide list of any additional resources to review if available, we are not familiar with standardized or approaches or protocol, but rather typically design each according to the specific client and project objectives. Provide annotated reference list of different types of assessments available

- Include web address as available
- Include attributes of each

Reid[16] provides a comprehensive description and evaluation of the two most widely implemented methods of watershed analysis developed for application within forested areas of the Pacific Northwest:

1. FEMAT. 1993. Forest Ecosystem Management Assessment Team. A Federal Agency Guide for Pilot Watershed Analysis. Version 1.2. Interagency Working Group, U.S. Department of Agriculture, Forest Service, Portland, OR. (*This applies only to forested lands.*)
2. Washington Forest Practices Board, 1995. Standard methodology for conducting watershed analysis under Chapter 222-22 WAC. Version 3.0. Washington Department of Natural Resources Forest Practices Division, Olympia, WA. (*This applies only to forested lands.)*

WA Agency Reviewers – please include any preferred resources for reach-scale assessment

3.4 Additional Reading

Montgomery, D.R., G. Grant, And K. Sullivan. 1995. Watershed analysis as a framework for

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Roni. P. et. al. 2002. A Review of Stream Restoration Techniques and a Hierarchical Strategy for Prioritizing Restoration in Pacific Northwest Watersheds. North American Journal of Fisheries Management 22:1-20. American Fisheries Society.

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[1] Roni, P., Beechie, T.J., Bilby, R.E., Leonetti, F.E., Pollock, M.M., and G.R. Pess, A Review of Restoration Techniques and a Hierarchical Strategy for Prioritizing Restoration in Pacific Northwest Watersheds, North American Journal of Fisheries Management 22:1-20, 2002.

[2] State of Washington, Joint Natural Resources Cabinet, 2001. Guidance on Watershed Assessment for Salmon. Governor's Salmon Recovery Office, Olympia, WA.

[3] State of Washington, Joint Natural Resources Cabinet, 2001. Guidance on Watershed Assessment for Salmon. Governor's Salmon Recovery Office, Olympia, WA.

[4] National Research Council. 1992. Restoration of Aquatic Ecosystems: Science, Technology, and Public Policy. National Academy Press, Washington, D.C. pp552.

[5] Reid, L.M. 1998. Cumulative watershed effects and watershed analysis. In: Naiman, R.J. and R. E. Bilby (editors) 1998. River Ecology and Management – Lessons from the Pacific Coastal Ecoregion. Springer-Verlag, Inc., New York. Page 477.

[6] Roni. P. et. al. 2002. A Review of Stream Restoration Techniques and a Hierarchical Strategy for Prioritizing Restoration in Pacific Northwest Watersheds. North American Journal of Fisheries Management 22:1-20. American Fisheries Society.

[7] WDNR, 1995. Standard methodology for conducting watershed analysis. Washington Forest Practices Board, Washington Departmen of Natural Resources, Olympia.

[8] Skagit Watershed Council. 1999. Application of the Skagit Watershed Council's strategy: river basin analysis of the Skagit and Samish basins – tools for salmon habitat restoration and protection. Skagit Watershed Council, Mount Vernon, Washington.

[9] Watershed Professionals Network. 1999. Oregon watershed assessment manual. Report to Governor's Watershed Enhancement Board, Salem, Oregon.

[10] State of Washington, Joint Natural Resources Cabinet, 2001. Guidance on Watershed Assessment for Salmon. Governor's Salmon Recovery Office, Olympia, WA.

[11] Reid, 1998. Cumulative Watershed Effects and Watershed Analysis – In: Naiman, R.J. and R. E. Bilby (editors) 1998. River Ecology and Management – Lessons from the Pacific Coastal Ecoregion. Springer-Verlag, Inc., New York. 705 pp.

[12] Booth, D.B., et. al. 2001. Urban Stream Rehabilitation in the Pacific Northwest. The Washington Water Resource. Volume 12, No. 1, Spring 2001.

[13] Madej. M.A. nad V. Ozaki. 1996. Channel response to sediment wave propagation and movement, Redwood Creek, California. Earth Surface Processes and Landforms 21:911-927.

[14] National Research Council. 1992. Restoration of Aquatic Ecosystems: Science, Technology, and Public Policy.

National Academy Press, Washington, D.C. pp552

[15] National Research Council, 1996. Upstream: Salmon and Society in the Pacific Northwest. National Academy Press, Washington D.C., 452 pp.

[16] Naiman, R.J. and R. E. Bilby (editors) 1998. River Ecology and Management – Lessons from the Pacific Coastal Ecoregion. Springer-Verlag, Inc., New York. 705 pp.